PROSOPIS (MIMOSACEAE) IN THE SAN JOAQUIN VALLEY, CALIFORNIA: VANISHING RELICT OR RECENT INVADER?

DAN C. HOLLAND[1]
Department of Biology,
California State University, Fresno,
Fresno 93740-0001

ABSTRACT

The presence of at least two species of mesquite (*Prosopis glandulosa* and *P. pubescens*) in the San Joaquin Valley of California has been explained previously as the result of the invasion of Mojavean floral elements during the Xerothermal period some 8000–5000 years B.P. I propose that a number of lines of negative evidence argue for the establishment and spread of both species within approximately the last 120 years.

The mesquites (Mimosaceae: *Prosopis*) are a group of woody legumes restricted to the New World. *Prosopis* contains 10 species that range from Argentina and Chile north to the west-central United States. Most species are large shrubs or trees, some of which exceed 12 m. In subtropical regions, *Prosopis* species are often physiognomic dominants or codominants that cover extensive areas.

Two of the four species of mesquite that occur in California are native. *Prosopis pubescens* Benth. (Screwbean or Tornillo) primarily inhabits washes and bajadas in the southern Mojave and Sonoran deserts in California, and ranges widely throughout the southwestern United States and Mexico. *Prosopis glandulosa* L. Benson (Honeybean mesquite) also ranges widely in the southwest and in the deserts of California. It is more widespread than *P. pubescens* in its habitat preferences, however, and occurs in xeric grasslands, on the fringes of lake beds, and in flood plains, washes, and other riparian areas. *Prosopis velutina* Woot. (Velvet mesquite) is native to the Arizona-Sonora region, and also has a scattered distribution in California, which suggests that it is naturalized in this area. Benson (1941) and Munz (1959) have considered *P. velutina* to be a variety of *P. glandulosa*. *Prosopis strombulifera* Lam. (Benth.) is native to South America and is established near Bard, Imperial Co. (Munz 1959).

The first three species noted have disjunct distributions in California, with populations present in the San Joaquin Valley (SJV)

[1] Present address: Department of Biology, University of Southwestern Louisiana, Lafayette 70504-2451.

MADROÑO, Vol. 34, No. 4, pp. 324–333, 1987

that are some distance from the main body of their range in the state. In this disjunct area, *P. glandulosa* occurs primarily along the floodplain of the north fork of the Kern River, between Bakersfield and the former bed of Buena Vista Lake. Isolated populations occur throughout the valley and adjacent foothills north to Alameda Co. and east to the Sierra Nevada as far north as Fresno Co. (Fig. 1). Benson (1941) reported an unvouchered occurrence of *P. glandulosa* in the Cuyama River Valley, San Luis Obispo Co. *Prosopis pubescens* is known only from Warthan and Los Gatos canyons in western Fresno Co. and San Emigdio Canyon in southwestern Kern Co. Hilu et al. (1982) reported *P. velutina* from the vicinity of Bakersfield, where it occurs with *P. glandulosa.*

Barbour and Major (1980) concluded that *P. glandulosa* became established in the SJV during the climatic warming trends of the Xerothermal period, between 8000–5000 yr B.P. At this time and during the Pleistocene, elements of the Mojavean biota presumably invaded the Central Valley. Such organisms included *Sceloporus magister* Hallowell (desert spiny lizard), *Xantusia vigilis* Baird (desert night lizard), *Gopherus agassizi* (Cooper) (desert tortoise), *Ephedra viridis* Cov., *E. californica* Wats., and *Yucca whipplei* Torr. As the climate cooled, some species were extirpated (e.g., the desert tortoise), whereas others became restricted to the drier parts of nearby mountains (e.g., the Diablo and Temblor ranges).

A number of lines of evidence, however, indicate that the presence and spread of *P. glandulosa* and *P. pubescens* in the SJV are due to human-induced factors, and that prior to the 1870's neither species existed there. Support for this hypothesis is based largely upon negative evidence, such as a lack of documentation of the extended occurrence of either species where it would be expected to exist. I summarize the salient points in the present paper.

Historical Evidence

Available historical accounts of expeditions through areas where mesquite now occurs or occurred in the recent past lack documentation of the presence of the species. A particularly interesting account is that of Lt. George Derby, who was commissioned by the War Department in 1850 to survey the "Tulare Valley" (the area between Tulare and Buena Vista lakes) for the purpose of establishing a military outpost. Derby's party traveled along the north bank of the north fork of the Kern River to the north shore of Buena Vista Lake. His account of the area (Boyd 1977) reads as follows: "Like other bodies of water in the valley, it is nearly surrounded by tules [*Scirpus*], and upon its north and east banks there is a heavy growth of willows. A slough, some sixty miles in length [Goose Lake Slough], connects it with the swamps and bodies of standing water in the bed

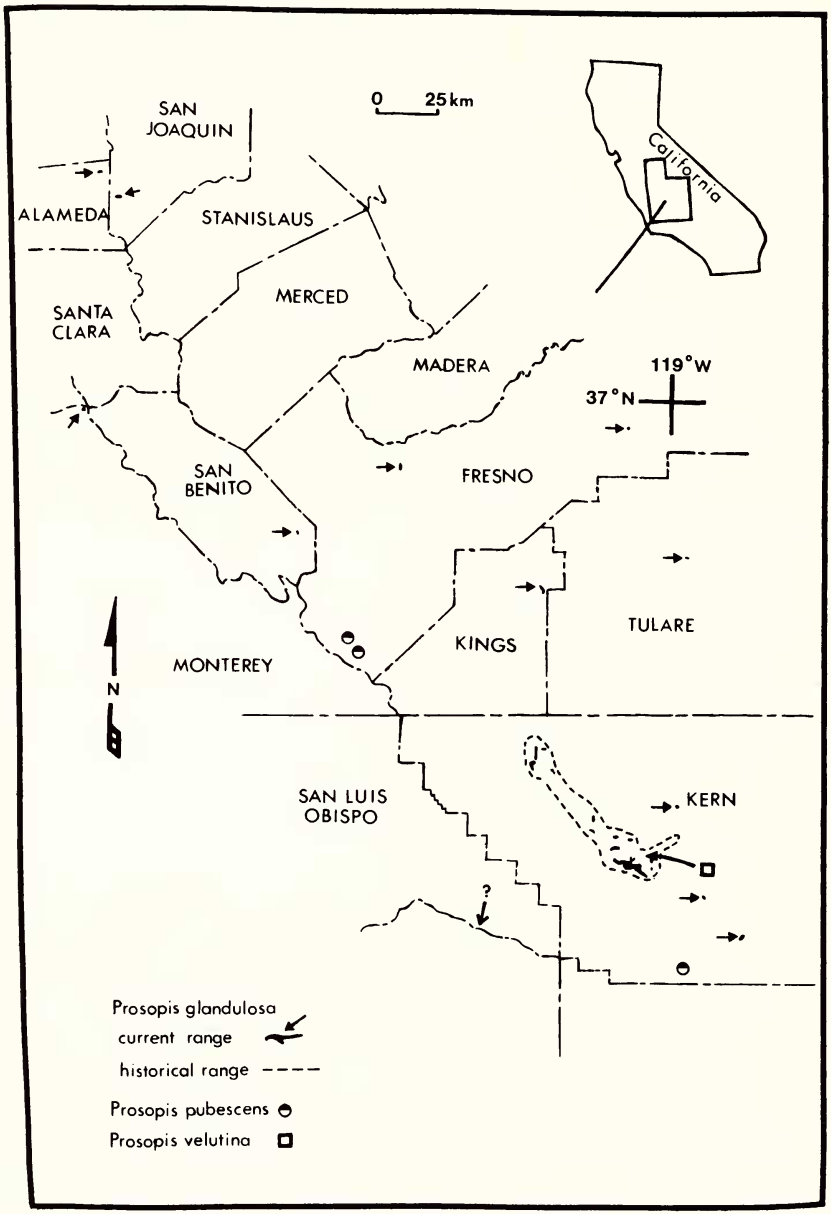

FIG. 1. Distribution of various species of *Prosopis* in the San Joaquin Valley, California. → = isolated populations, usually of less than 10 trees. ? = unvouchered occurrence in the vicinity of the Cuyama River, San Luis Obispo Co.

of the Ton Tache [south of present-day Alpaugh], and through them with the great northern lake [Tulare Lake]. The surrounding country is sterile and unproductive when not an absolute swamp . . . nothing can be conceived more inappropriate than its name, for no place can be imagined more forlorn or desolate in appearance". Traveling north by way of the east side of Goose Lake Slough, Derby continued his appraisal of the region, noting that it was of "precisely the same character throughout—barren, decomposed soil with no trace of vegetation but a few straggling Artemesias [presumably *Allenrolfea* or *Atriplex*], except on the margins of the creeks". Given Derby's attention to details of the flora in areas such as the Tule River and Poso Creek, it seems curious that he would fail to note the presence of a plant as conspicuous as mesquite, now one of the largest and relatively common elements of the flora in this area (Fig. 2).

The account of W. H. Brewer (Farquhar 1966) concerning the area of Corral Hollow (San Joaquin and Alameda cos.) is fairly detailed, noting the species and relative abundance of trees in an area where they are often scarce. Again there is no mention of mesquite or even anything that might resemble it.

War Department surveys in the 1850's (Williamson 1853) for a railroad route through the Central Valley and their botanical collections also failed to document or note the presence of mesquite, as did the botanical portion of the California Geological Survey of the area (Gray 1876). In 1983, I retraced most of the route followed by the railroad survey and noted the occurrence of mesquite in at least two areas. A vegetational survey (Davy 1898) of the "waste lands" (alkali sink areas) southwest of Bakersfield in 1896 failed to note the presence of mesquite. The first published reference confirming the presence of *P. glandulosa* in this area was that of Linton (1908), noting that along Buena Vista Lake "on the north shore for several miles is an alkaline desert with an occasional patch of mesquite and sage."

I examined over 100 photographs taken from the late 1880's to the early 1900's in the hypothesized area of establishment and was unable to identify anything that resembled mesquite, although other native taxa (*Populus, Salix, Allenrolfea*) were readily observable.

There is a consistent lack of herbarium collections from the proposed areas of origin during the time period of concern. This is a weak argument, as the number and scope of collections from the SJV were limited, and the collectors were often more concerned with annuals and smaller perennials (Eastwood 1893). The earliest known collection is a specimen of *P. glandulosa* from the area of Buttonwillow, Kern Co., collected in 1914 (CAS #65104).

A paucity of paleobotanical information exists concerning the flora of the valley floor at the time of the presumed invasion and estab-

FIG. 2. *Prosopis–Atriplex* association near the former site of Buena Vista Lake and in the approximate vicinity of the route traversed by Derby's party.

lishment of many Mojavean elements. Available information does not indicate that mesquite was present in areas near Buena Vista Lake (Mason 1944). Mesquite did reach the "rim" of the San Joaquin Valley in the Pliocene, however, as indicated by fossil material from the vicinity of Tehachapi, at the current western edge of the Mojave Desert (Axelrod 1950). Analyses of fossil pollen records in Arizona have documented the long-term existence of mesquite (Martin 1963), but I was unable to find any core sample data from the area and time period of concern for this study.

ETHNOBOTANICAL EVIDENCE

The seed pods of *P. glandulosa* are and were used widely as a food source by the aboriginal inhabitants of the southwestern United States and adjacent Mexico, and the fibers were utilized to some extent in basketry. The area around Buena Vista and Tulare lakes was inhabited by various groups of the Valley Floor Yokuts (Latta 1949). Ethnographers, e.g., Alfred Kroeber and Frank Latta, have gained valuable insights into the ecology of California aboriginals, which included their uses of the native flora. Latta's (1949) study of the Yokut culture made no mention of the use of mesquite despite an otherwise extensive compendium of food, fiber, and medicinal plants. Driver (1937) questioned members of Central Valley and

Death Valley tribes about their use of mesquite. Responses from the tribes of Death Valley and adjacent areas indicated extensive use, whereas there were no such indications from Valley Floor peoples. Furthermore, use of mesquite fibers in baskets among tribes of the Mojave Desert was documented but was conspicuously lacking among Valley Floor tribes (Merrill 1923).

Environmental Disturbance

The areas in which I suspect *P. glandulosa* and *P. pubescens* initially became established have an extensive history of environmental disturbance, both human-induced and otherwise (floods, drought). This situation may have fostered the establishment of mesquite. I suggest that in the interval from 1870–1890 *P. glandulosa* became established in the area between Bakersfield and Buena Vista Lake. The hypothesized mechanism of establishment was ingestion of seed pods by cattle in areas where mesquite occurs naturally followed by transport of those cattle by rail to the SJV, defecation by the cattle, and subsequent germination of the seeds. Benson (1941) implicated this mechanism in the establishment of mesquite in Louisiana and Missouri. I suspect a similar situation led to the establishment of *P. pubescens* in the vicinity of Coalinga in western Fresno Co. Darrell Zwang (pers. comm.), a long-term (70+ yr) resident of the area, noted that cattle transport was nonstop, increasing the probability that this mechanism occurred. The seeds of *P. velutina* are known to remain viable for extended periods of time (44 yr) (Martin 1948), which also increases the probability of establishment. If mesquite was carried as fodder in cattle cars, establishment might be due to incidental release into the habitat.

The establishment of mesquite in these and similar sites was probably facilitated by at least two types of environmental disturbances. Many areas in which *Prosopis* occurs are situated in flood plains or washes that are periodically inundated or have high water tables. Prior to the construction of Isabella Dam in 1952, much of the Buena Vista Lake area was unsuitable for continuous agricultural use due to recurrent flooding. In certain areas of the southwest, similar situations have fostered the establishment of extensive mesquite-dominated communities (Minckley and Clark 1984).

Heavy grazing has been shown to facilitate the establishment and spread of mesquite (Glendening 1952, Martin 1975). The number of cattle in Kern Co. increased over 500% between 1870–1880, and an additional 350% from 1880–1890. By the 1890's, approximately 16% of all the cattle in California were being grazed in Kern Co. (Burcham 1957). Further spread of *Prosopis* may have been facilitated by the ingestion of seed pods from maturing trees and movement of cattle to other areas. Populations in Alameda and Fresno

cos. may have become established as the result of deliberate plantings.

Ecological Considerations

The ecology of the two species of *Prosopis* lends support to this hypothesis of establishment. *Prosopis glandulosa* and *P. pubescens* are known to invade disturbed areas, particularly in association with drought and overgrazing (Caraher 1970, Herbel et al. 1972, Cable 1973). The physiognomy of an area such as the Santa Rita Experimental Range in Arizona (Martin 1973) can change to such an extent in as little as 50 yr that to those unfamiliar with the original appearance of the site, mesquite might appear to be a "normal" dominant. Historical (Hastings and Turner 1965) and recent (Minckley and Clark 1984) evidence of this type has been noted in the appearance of mesquite-dominated floodplains in Arizona.

I have observed extensive, apparently suitable habitat for mesquite in the SJV, and, thus, it is curious that I have found neither species more widespread. For example, several large canyons with similar relief and soil conditions occur to the north and south of the Fresno Co. populations of *P. pubescens,* but the species is not known from any of these.

Prosopis glandulosa formerly covered an estimated 25–35 km^2 in the Old River area of Kern Co. (Bill Asserson, pers. comm.), where it coexisted with a mixture of *Allenrolfea occidentalis, Suaeda moquinii, Atriplex polycarpa,* and *A. lentiformis.* Estimates by Werschkull et al. (1983) indicate that the *Prosopis–Atriplex* association covered over 57,000 ha at its peak. Based upon my research, I estimate that at most, only 20,000–25,000 ha in the SJV supported mesquite in any association, and of this only 8000–12,000 ha supported high-density stands. Given the extensive areas that have seemingly suitable soil and climatic characteristics and the invasive abilities of this group, I estimate that the potential range for *Prosopis* spp. in the SJV and vicinity was or is greater than 75,000 ha. I suggest that this area has not been occupied due to insufficient time for the species to spread since their advent in the late 1800's. Additionally, massive habitat alteration and concurrent destruction of many populations by humans has slowed the spread.

Current Status

The status of mesquite populations in the SJV is of concern to conservationists who consider the *Prosopis–Atriplex* association to be a threatened plant community (Jack Zaninovich, pers. comm.). Construction of the Central Valley Water Project and the California Aqueduct resulted in the conversion of a considerable percentage of the remaining wildlands of the Central Valley to agricultural use.

Mesquite-dominated communities were estimated to cover approximately 20,000 ha in Kern Co. in 1963 (CDFG 1965), but patterns of land use over the next 20 yr were projected to reduce this cover to zero. Major reductions in the habitats supporting mesquite did take place over this time interval: approximately 2000 ha remained in Kern Co. in 1979 (Bill Asserson, pers. comm.), and 6500 ha remained in the Tulare basin as a whole (Werschkull et al. 1983). I estimate that as of summer 1986 about 5000 ha of habitat supporting *P. glandulosa* remained in the SJV. Of this, only 15–20% supports vigorous populations. Lowering of water tables in many areas may result in the decline of this species.

I estimate the amount of habitat supporting *P. pubescens* to be less than 1000 ha (primarily in Warthan Canyon), and the number of trees probably does not exceed a few hundred. The status of the populations in Los Gatos Canyon and San Emigdio Canyon is unknown. *Prosopis velutina* probably is represented by only a few trees in the vicinity of Bakersfield (Hilu et al. 1982).

Populations of *Prosopis* are commonly sympatric with other genera of native plants, including *Atriplex, Allenrolfea, Cephalanthus, Salix,* and *Suaeda.* Destruction of mesquite populations will necessarily entail the alteration of a large percentage of the remaining areas of native vegetation in the southern (San Joaquin) valley. For example, the largest remaining population of *P. glandulosa* occurs along the lower Kern River southwest of Bakersfield. Approximately 1100 ha of this area is being developed as a ground-water recharge facility for the City of Bakersfield. This action will eliminate most of the native habitat containing mesquite (Stetson Engineers 1983).

Conclusions

Historical, ethnobotanical, and ecological evidence indicate that one or both species of mesquite may have naturalized recently (<120 yr) in the SJV. This is equivocal, however, as ". . . I have never seen, and never shall see, that the cessation of the evidence of existence is necessarily evidence of the cessation of existence" (de Morgan 1906). The question of status might be resolved through paleobotanical evidence or core sampling that documents the presence of the species well prior to the hypothesized period of establishment (1870–1890). Mesquite, however, may deposit several growth rings per year (Tom Griggs, pers. comm.), which may frustrate efforts to date individuals.

Monitoring of mesquite populations in the southern SJV is of primary importance. Valuable scientific opportunities will be lost with their further decline or elimination. If the species are indeed native, the chance will be lost to study their associations with floral elements that do not occur elsewhere. If my recent-invasive hy-

pothesis is correct, the destruction of mesquite-dominated communities represents the loss of an unusual opportunity to better understand the nature of historical habitat disturbance and invasive plant ecology.

Acknowledgments

Inquiries concerning specimens of *Prosopis* were conducted at the following herbaria—Bakersfield Junior College, California Department of Food and Agriculture, California State College–Bakersfield, Merced Junior College, CAS, CSLA, CSPU, DS, FSC, LA, OBI, POM, RSA, SJSU, UC, and UCSB. I thank Daniel Axelrod, Jim Bartel (USFWS), Annetta Carter, Elizabeth Coley, W. J. Ferlatte, Wayne Ferren, Marc Hayes, James Jackson, Robert Jaeger, William Reese, Barry Tanowitz, and an anonymous reviewer for editorial comments. I also thank Bill Asserson (CDFG), Lyman Benson, Ben Chichester, Tom Griggs, Khirdir Hilu, Howard Latimer, Maynard Moe, John Stebbins, Jack Zaninovich, Darrell Zwang, and the curators of the herbaria noted. This paper is dedicated to the memory of Lt. John Reed (CDFG) who gave his life in the protection of California's natural resources.

Literature Cited

Axelrod, D. 1950. Evolution of desert vegetation in western North America. Carnegie Inst. Wash. Publ. 590:215–360.

Barbour, M. and J. Major. 1980. Terrestrial vegetation of California. John Wiley & Sons, New York.

Benson, L. 1941. The mesquites and screw-beans of the United States. Amer. J. Bot. 28:748–754.

Boyd, W. 1977. Kern County wayfarers 1844–1881. Kern Co. Hist. Soc. & Kern Co. Museum, Bakersfield, CA.

Burcham, L. 1957. California range land: a historico-ecological study of the range resource in California. Div. of For., State of California, Sacramento.

Cable, D. 1973. Invasion of semi-desert grassland by Velvet mesquite and associated vegetation changes. J. Ariz. Acad. Sci. 8:127–134.

California Department of Fish and Game. 1965. California Fish & Wildlife Plan. Vol. III. Supporting data. Sacramento.

Caraher, D. 1970. Effects of longtime livestock exclusion versus grazing on the desert grassland of Arizona. M.S. thesis, Univ. Arizona.

Davy, J. 1898. Natural vegetation of alkali lands. Calif. Agr. Exp. St., Berkeley Rrt. 1895–1898:63–75.

Driver, H. 1937. Culture element distributions VI: southern Sierra Nevada. Univ. Cal. Publ. Am. Arch. and Ethn. 37:53–154.

Eastwood, A. 1893. Field notes at San Emigdio. Zoe 4:144–147.

Farquhar, F. P., ed. 1966. Up and down California in 1860–1864: the journal of Dr. William H. Brewer. Univ. California Press, Berkeley.

Glendening, G. E. 1952. Some quantitative data on the increase of mesquite and cactus on a desert grassland range in southern Arizona. Ecology 33:319–328.

Gray, A. 1876. Botany. Vol. I. Gamopetalae. Geological Survey of California. Welch, Bigelow & Co. Univ. Press, Cambridge, MA.

Hastings, J. R. and R.M. Turner. 1965. The changing mile: an ecological study of vegetation change with time in the lower mile of an arid and semiarid region. Univ. Arizona Press, Tucson.

Herbel, C., F. Ares, and R. Wright. 1972. Drought effects on a semi-desert grassland range. Ecology 53:1084–1093.

Hilu, K., S. Boyd, and P. Felker. 1982. Morphological diversity and taxonomy of California mesquites (*Prosopis,* Leguminosae). Madroño 29:237–254.

LATTA, F. 1949. Handbook of Yokuts Indians. Bear State Books, Oildale, CA.
LINTON, C. 1908. Notes from Buena Vista Lake, May 20 to June 16, 1907. Condor 10:196–198.
MARTIN, P. S. 1963. The last 10,000 years: a fossil pollen record of the American southwest. Univ. Arizona Press, Tucson.
MARTIN, S. C. 1948. Mesquite seeds remain viable after 44 years. Ecology 29:393.
———. 1973. Santa Rita Experimental Range: your facility for research on semi-desert ecosystems. J. Ariz. Acad. Sci. 8:56–67.
———. 1975. Ecology and management of southwestern semi-desert grass-shrub ranges: the status of our knowledge. U.S.D.A. Forest Service Res. paper RM–156.
MASON, H. 1944. A Pleistocene flora from the McKittrick asphalt deposits of California. Proc. Cal. Acad. Sci. 25:221–234.
MERRILL, R. 1923. Plants used in basketry by the California Indians. Univ. California Publ. Am. Arch. and Ethn. 20.
MINCKLEY, W. and T. CLARK. 1984. Formation and destruction of a Gila River Mesquite Bosque community. Desert Plants 6:23–30.
DE MORGAN, W. 1906. Joseph Vance: an ill-written autobiography. H. Holt and Co., New York.
MUNZ, P. 1959. A California flora. Univ. California Press, Berkeley.
STETSON ENGINEERS, INC. 1983. Draft Environmental Impact Report—2800 acre ground-water recharge facility along the Kern River for the City of Bakersfield.
WERSCHKULL, G., T. GRIGGS, and J. ZANINOVICH. 1983. Tulare Basin protection plan. Publ. Calif. Nature Conservancy.
WILLIAMSON, R. 1853. Report on explorations in California for railroad routes to connect with the routes near the 35th and 32nd Parallels of north latitude. U.S. War Dept.

(Received 27 Nov 1985; revision accepted 16 Jun 1987.)

ANNOUNCEMENT

1987 AWARDS PRESENTED BY ASPT

The George R. Cooley Award for 1987 was presented to Robert Wyatt of the University of Georgia, Athens, for his paper co-authored with Ireneusz J. Odrzykoski and Ann Stoneburner entitled "Allopolyploidy in bryophytes: recurring origins of *Plagiomnium medium*." The award is given annually by the American Society of Plant Taxonomists for the outstanding contributed paper in plant systematics presented at the annual meeting.

The fourth Asa Gray Award was presented to Reed C. Rollins of Harvard University, Cambridge, Massachusetts. The Asa Gray Award is given by the American Society of Plant Taxonomists to honor an individual "for outstanding accomplishments pertinent to the goals of the Society." The award has been presented to Rogers McVaugh at the 1984 meeting, Arthur Cronquist at the 1985 meeting, and Lincoln Constance at the 1986 meeting.